

additional adjusting functions by the advanced calculation can be performed efficiently from the starting point of an automatic performance.

Moreover, even when the advanced calculation of tone waveform sample values can not be conducted due to great loads placed on the arithmetic processing section by other processing, the present invention can prevent an unwanted break in generated sounds because the waveform calculating steps are always taken to prepare tone waveform sample values.

In addition, the present invention is characterized in that when calculating tone waveform sample values, a detection is made of an amount of calculation necessary for the arithmetic processing section to conduct other processing and the waveform sample value calculation is executed with different calculating precision which is selectable in accordance with the detected calculation amount for the other processing. Even when the arithmetic processing section is busy with the other processing, loads on the arithmetic processing section can be effectively lessened by selecting low calculating precision to reduce the amount of tone waveform sample calculation. As a result, generation of tone waveform data can be continued with no break and without influencing the other processing.

Moreover, according to the present invention, tone generating processing based on an automatic performance is executed in advance during a period when tone generating processing based on a real-time performance is not placing heavy burdens on the arithmetic processing section. As a result, the burdens on the arithmetic processing section can be distributed timewise, which achieves greatly increased operational efficiency of the arithmetic processing section.

What is claimed is:

1. A method of generating a tone waveform based on automatic performance information, using a processor device executing a plurality of different programs on a time division basis, said method including executing a waveform calculating process for calculating tone waveform samples on the basis of one of the programs by sharing the processor device with another process based on another one of the programs, said method comprising the steps of:

detecting an available time portion in which said processor device is not currently used for the other process, as available processing capability for the waveform calculating process;

calculating a plurality of tone waveform samples based on the performance information in advance of predetermined generation timing thereof by executing the waveform calculating process using said available processing capability detected by said step of detecting, said step of calculating including a step of storing the calculated tone waveform samples in a memory; and generating a tone waveform by reading out the tone waveform samples from the memory.

2. A method as defined in claim 1 wherein said step of calculating calculates one or more predetermined units of the tone waveform samples depending on said detected available processing capability, each said unit being a predetermined number of the tone waveform samples.

3. A method as defined in claim 1 wherein said step of calculating starts calculating the tone waveform samples in advance of said step of generating, and said step of generating starts reading the tone waveform samples from the memory after a plurality of the tone waveform samples are stored in the memory.

4. A method as defined in claim 1 wherein when more than a predetermined number of unread tone waveform samples

04567-10000

are not resident in the memory, said step of calculating calculates a predetermined number of tone waveform samples irrespective of said detected available processing capability.

Pub.  
C1

5. (Amended) A method of generating a tone waveform based on [automatic] performance information, using a processor device executing a plurality of different programs on a time division basis, said method including executing a waveform calculating process for calculating tone waveform samples on the basis of one of the programs by sharing the processor device with another process based on another one of the programs, said method comprising the steps of:

detecting an amount of calculation time necessary for the other process, when the waveform calculating process is to be executed; and

calculating tone waveform samples by selectively executing the waveform calculating process that involves a variable calculation amount which depends on said amount of calculation time necessary for the other process detected by said step of detecting;

6. A method as defined in claim 5 wherein said step of calculating calculates the tone waveform samples with different precision depending on the calculation amount involved in the waveform calculating process.

7. A method of generating tone waveforms corresponding to first performance information based on a real-time performance and second performance information based on an automatic performance, which includes executing a waveform calculating process for calculating tone waveform samples on the basis of said first and second performance information, respectively, by use of a common arithmetic processing section, said method comprising the steps of:

calculating a predetermined number of first tone waveform samples for each predetermined period on the basis of said first performance information supplied in response to a real-time performance;

detecting a portion of processing capability of said arithmetic processing section which is not currently occupied by a process for calculating said first tone waveform samples, as available processing capability for generation of a tone waveform based on said second performance information;

calculating second tone waveform samples based on said second performance information in advance of predetermined generation timing thereof, using said available processing capability detected by said step of detecting;

storing in a memory said first and second tone waveform samples calculated by said steps of calculating; and generating tone waveforms corresponding to the real-time performance and automatic performance by synchronously reading said first and second tone waveform samples from the memory.

8. A method as defined in claim 7 wherein said step of storing in a memory includes a step of adding said first and second tone waveform samples for each sample corresponding to same generation timing so as to store resultant added tone waveform samples in the memory, and said step of generating reads out the added tone waveform samples from the memory.

9. (Amended) A method of generating tone waveforms corresponding to first performance information based on a real-time performance and second performance information based on an automatic performance, which includes executing a waveform calculating process for calculating tone waveform samples on the basis of said first

658027-2335460

generating tone waveform samples corresponding to the real-time performance and automatic performance by, at regular sampling intervals, reading out from the memory said first and second tone waveform samples corresponding to each same said block period.

12. (Amended) A machine-readable recording medium containing a group of instructions to cause said

Pub.  
C2

[means for] instructing the machine to generate a tone waveform based on the calculated tone waveform samples.

[means for] instructing the machine to generate tone waveforms corresponding to the real-time performance and automatic performance by synchronously reading said first and second tone waveform samples from the memory.

[means for] instructing the machine to calculate a predetermined number of first tone waveform samples for each predetermined block period on the basis of said first performance information supplied in response to a real-time

THE UNIVERSITY OF CHICAGO

performance, including [means for] a step of instructing the machine to calculate, at [an optional] a time within first said block period, said predetermined number of first tone waveform samples to be generated within second said block period following said first block period, and [means for] a step of instructing the machine to store the calculated first tone waveform samples in a memory, and sequentially read out at regular sampling intervals in said second block period said first tone waveform samples stored in the memory;

[means for] instructing the machine to detect a portion of the processing capability of said arithmetic processing section which is not currently occupied by the process of calculating said first tone waveform samples, as available processing capability for generation of a tone waveform based on said second performance information;

[means for] instructing the machine to calculate second tone waveform samples based on said second performance information in advance of predetermined generation timing thereof, using said detected available processing capability, said [means for] step of instructing the machine to calculate second tone waveform samples including [means for] a step of instructing the machine to store in a memory the calculated second tone waveform samples; and

[means for] instructing the machine to generate tone waveform samples corresponding to the real-time performance and automatic performance by, at regular sampling intervals, reading out from the memory said first and second tone waveform samples corresponding to each same said block period.

15. (Amended) A computer system for generating a tone waveform based on automatic performance information, said computer system comprising:

a memory device that stores a plurality of programs; and

a processor device that executes a waveform generating process including a waveform calculating process for calculating tone waveform samples based on a predetermined one of said programs, and one or more other processes based on other of said programs in a parallel manner on a time-divisional basis,

wherein said [processor device] predetermined one of said programs includes the steps of:

[means for] detecting an available time portion in which said processor device is not currently occupied by the other process, as available processing capability for the waveform calculating process;

[means for] calculating a plurality of tone waveform samples based on the performance information in advance of predetermined generation timing thereof by executing the waveform calculating process using said available processing capability detected by said [means for] step of detecting;

[means for] storing the calculated tone waveform samples in a memory; and

[means for] generating a tone waveform by reading out the tone waveform samples from the memory.

16. (Amended) A computer system for generating a tone waveform based on performance information, said computer system comprising:

a memory device that stores a plurality of programs; and

a processor device that executes a waveform generating process including a waveform calculating process for calculating tone waveform samples based on a predetermined one of the said programs and one or more other processes based on other of said programs in a parallel manner on a time-division basis,

wherein said [processor device] predetermined one of said programs includes the steps of:

[means for] detecting an amount of calculation time necessary for said other process, when the waveform calculating process is to be executed; and

00456077-120899

sub.  
C3

17. (Amended) A computer system for generating tone waveforms corresponding to first performance information based on a real-time performance and second performance information based on an automatic performance, which executes a waveform calculating process for calculating tone waveform samples on the basis of said first and second performance information, respectively, by use of a common arithmetic processing section, said [computer system] waveform calculating process comprising the steps of:

[means for] detecting a portion of processing capability of said arithmetic processing section which is not currently occupied by a process for calculating said first tone waveform samples, as available processing capability for generation of a tone waveform based on said second performance information;

[means for] storing in a memory said first and second tone waveform samples calculated by said [means for] steps of calculating; and

18. (Amended) A computer system for generating tone waveforms corresponding to first performance information supplied in response to a real-time performance and second performance information supplied in response to an automatic performance, which executes a waveform calculating process for calculating tone waveform samples on the basis of said first and second performance information, respectively, by use of a common arithmetic processing section, said [computer system] waveform calculating process comprising the steps of:

[means for] detecting a portion of processing capability of said arithmetic processing section which is not currently occupied by a process for calculating said first tone waveform samples, as available processing capability for generation of a tone waveform based on said second performance information;

[means for] calculating second tone waveform samples based on said second performance information in

1. 1. The first part of the report  
 2. 2. The second part of the report  
 3. 3. The third part of the report  
 4. 4. The fourth part of the report  
 5. 5. The fifth part of the report  
 6. 6. The sixth part of the report  
 7. 7. The seventh part of the report  
 8. 8. The eighth part of the report  
 9. 9. The ninth part of the report  
 10. 10. The tenth part of the report  
 11. 11. The eleventh part of the report  
 12. 12. The twelfth part of the report  
 13. 13. The thirteenth part of the report  
 14. 14. The fourteenth part of the report  
 15. 15. The fifteenth part of the report  
 16. 16. The sixteenth part of the report  
 17. 17. The seventeenth part of the report  
 18. 18. The eighteenth part of the report  
 19. 19. The nineteenth part of the report  
 20. 20. The twentieth part of the report  
 21. 21. The twenty-first part of the report  
 22. 22. The twenty-second part of the report  
 23. 23. The twenty-third part of the report  
 24. 24. The twenty-fourth part of the report  
 25. 25. The twenty-fifth part of the report  
 26. 26. The twenty-sixth part of the report  
 27. 27. The twenty-seventh part of the report  
 28. 28. The twenty-eighth part of the report  
 29. 29. The twenty-ninth part of the report  
 30. 30. The thirtieth part of the report  
 31. 31. The thirty-first part of the report  
 32. 32. The thirty-second part of the report  
 33. 33. The thirty-third part of the report  
 34. 34. The thirty-fourth part of the report  
 35. 35. The thirty-fifth part of the report  
 36. 36. The thirty-sixth part of the report  
 37. 37. The thirty-seventh part of the report  
 38. 38. The thirty-eighth part of the report  
 39. 39. The thirty-ninth part of the report  
 40. 40. The fortieth part of the report  
 41. 41. The forty-first part of the report  
 42. 42. The forty-second part of the report  
 43. 43. The forty-third part of the report  
 44. 44. The forty-fourth part of the report  
 45. 45. The forty-fifth part of the report  
 46. 46. The forty-sixth part of the report  
 47. 47. The forty-seventh part of the report  
 48. 48. The forty-eighth part of the report  
 49. 49. The forty-ninth part of the report  
 50. 50. The fiftieth part of the report  
 51. 51. The fifty-first part of the report  
 52. 52. The fifty-second part of the report  
 53. 53. The fifty-third part of the report  
 54. 54. The fifty-fourth part of the report  
 55. 55. The fifty-fifth part of the report  
 56. 56. The fifty-sixth part of the report  
 57. 57. The fifty-seventh part of the report  
 58. 58. The fifty-eighth part of the report  
 59. 59. The fifty-ninth part of the report  
 60. 60. The sixtieth part of the report  
 61. 61. The sixty-first part of the report  
 62. 62. The sixty-second part of the report  
 63. 63. The sixty-third part of the report  
 64. 64. The sixty-fourth part of the report  
 65. 65. The sixty-fifth part of the report  
 66. 66. The sixty-sixth part of the report  
 67. 67. The sixty-seventh part of the report  
 68. 68. The sixty-eighth part of the report  
 69. 69. The sixty-ninth part of the report  
 70. 70. The seventieth part of the report  
 71. 71. The seventy-first part of the report  
 72. 72. The seventy-second part of the report  
 73. 73. The seventy-third part of the report  
 74. 74. The seventy-fourth part of the report  
 75. 75. The seventy-fifth part of the report  
 76. 76. The seventy-sixth part of the report  
 77. 77. The seventy-seventh part of the report  
 78. 78. The seventy-eighth part of the report  
 79. 79. The seventy-ninth part of the report  
 80. 80. The eightieth part of the report  
 81. 81. The eighty-first part of the report  
 82. 82. The eighty-second part of the report  
 83. 83. The eighty-third part of the report  
 84. 84. The eighty-fourth part of the report  
 85. 85. The eighty-fifth part of the report  
 86. 86. The eighty-sixth part of the report  
 87. 87. The eighty-seventh part of the report  
 88. 88. The eighty-eighth part of the report  
 89. 89. The eighty-ninth part of the report  
 90. 90. The ninetieth part of the report  
 91. 91. The ninety-first part of the report  
 92. 92. The ninety-second part of the report  
 93. 93. The ninety-third part of the report  
 94. 94. The ninety-fourth part of the report  
 95. 95. The ninety-fifth part of the report  
 96. 96. The ninety-sixth part of the report  
 97. 97. The ninety-seventh part of the report  
 98. 98. The ninety-eighth part of the report  
 99. 99. The ninety-ninth part of the report  
 100. 100. The hundredth part of the report

advance of predetermined generation timing thereof, using said available processing capability detected by said [means for] step of detecting, said [means for] step of calculating second tone waveform samples also storing in a memory the calculated second tone waveform samples; and

66027-1335160

✱ ✱ ✱ ✱ ✱

# THE UNIVERSITY OF CHICAGO



19. A method of generating a tone waveform by a processor which executes a waveform value calculating process, in parallel with another process, for calculating a tone waveform value for each sampling timing on the basis of performance information, said method comprising the steps of:

detecting a remaining available portion of processing capability of said processor that is not currently used by the other process;

executing the waveform value calculating process based on the performance information using the detected remaining available portion of processing capability so as to generate a given quantity of tone waveform values, wherein said given quantity corresponds to the detected remaining available portion, and storing the generated tone waveform values in a storage section;

determining whether the waveform value calculating process in said step of executing is being executed in advance of given read timing;

when said step of determining determines that the waveform value calculating process is not being executed in advance of the given read timing, calculating a given quantity of tone waveform values on the basis of the performance information and storing the calculated tone waveform values in the storage section; and

generating a tone waveform by reading out, from the storage section, the tone waveform values at the read timing arriving at given time intervals.

20. A method of generating a tone waveform by a processor which executes a waveform value calculating process, in parallel with another process, for calculating a tone waveform value for each sampling timing on the basis of received performance information, said method comprising the steps of:

calculating a given quantity of tone waveform values in advance of given read timing, by executing the waveform value calculating process based on the performance information;

storing the tone waveform values calculated by said calculation step in storage locations of a storage section indicated by writing location data and renewing the writing location data;

generating a tone waveform by reading out, from storage locations of the storage section indicated by reading location data, the tone waveform values at the read timing arriving at given time intervals and then renewing the reading location data; and

controlling, in response to a difference between said writing location data and reading location data, calculation progression of said step of calculating.

21. A method as recited in claim 20 which further comprises a step of detecting a remaining available portion of processing capability of said processor that is not currently used by the other process, and wherein said step of calculating calculates a quantity of tone waveform values corresponding to the remaining available portion detected by said step of detecting, by executing the waveform value calculating process based on the performance information using the detected remaining available portion.

22. A method as recited in claim 21 wherein said storing step further comprises the step of providing a ring buffer for said storage section.

23. A method as recited in claim 20 wherein said storing step further comprises the step of providing a ring buffer for said storage section.

24. A method of generating a tone waveform by a processor which executes a waveform value calculating process, in parallel with another process, for calculating a tone waveform value for each sampling timing on the basis of received performance information, said method comprising the steps of:

detecting a remaining available portion of processing capability of said processor that is not currently used by the other process;

calculating a given quantity of tone waveform values in advance of given read timing, by executing the waveform value calculating process based on the performance information;

storing the tone waveform values calculated by said step of calculating in storage locations of a storage section indicated by writing location data and renewing the writing location data;

generating a tone waveform by reading out, from storage locations of the storage section indicated by reading location data, the tone waveform values at read timing arriving at given time intervals and renewing the reading location data;

further calculating a given quantity of tone waveform values, on the basis of a relationship between said reading location data and said writing location data, by executing the waveform value calculating process based on the performance information;  
and

further storing the tone waveform values calculated by said step of further calculating in storage locations of the storage section corresponding to the writing location data and renewing the writing location data.

25. A method as recited in claim 24 wherein said storing step further comprises the step of providing a ring buffer for said storage section.

*Sub 25*  
~~26. A tone waveform synthesizing apparatus comprising:~~

*a* ~~storage adapted to temporarily store a plurality of tone waveform samples, said storage permitting the writing and reading, independently of each other, in a parallel fashion; and~~

*a* ~~a processor coupled to said storage and adapted to generate a plurality of tone waveform samples in advance of predetermined reproduction timing, said processor adapted to control writing of the generated tone waveform samples into said storage and reading out the tone waveform samples from said storage at said reproduction timing, the writing and reading into and from said storage being controlled independently of each other and also in such a manner that an advance of the writing does not outpace an advance of the reading.~~

27. A tone waveform synthesizing apparatus as recited in claim 26 wherein said storage permits the writing and reading, independently of each other, in accordance with separate write instruction and readout instruction signals, respectively, and

wherein said processor is adapted to control the write instruction signal so that the tone waveform samples are sequentially written into said storage from a beginning of a predetermined storage region of said storage and, upon arrival at an end of the predetermined storage region, the writing of the tone waveform samples returns to the beginning of the predetermined storage region and also that a writing location, in the storage region, indicated by the write instruction signal does not get ahead of a reading location, in the storage region, indicated by the read instruction signal.

66807-120899

28. A method of generating a tone waveform, said method comprising the steps of:  
generating a plurality of tone waveform samples in advance of predetermined  
reproduction timing:

*Pub.  
175*  
writing, into a storage, the plurality of tone waveform samples produced by said  
generating step, said storage being capable of writing and reading, independently of each  
other, in a parallel fashion:

reading out the stored tone waveform samples from said storage at said  
reproduction timing: and

controlling writing and reading into and from said storage by said steps of writing  
and reading independently of each other and also in such a manner that an advance of the  
writing does not outpace an advance of the reading.

29. A method as recited in claim 28 wherein said steps of writing and reading into  
and from said storage further comprise the steps of being performed, independently of  
each other, in accordance with separate write instruction and readout instruction signals,  
respectively, and

wherein said step of controlling further comprises the step of controlling the write  
instruction signal so that the tone waveform samples are sequentially written into said  
storage from a beginning of a predetermined storage region of said storage and, upon  
arrival at an end of the predetermined storage region, the writing of the tone waveform  
samples returns to the beginning of the predetermined storage region and also that a  
writing location, in the storage region, indicated by the write instruction signal does not get  
ahead of a reading location, in the storage region, indicated by the read instruction signal.

668027-1235460

30. A method of generating a tone waveform based on performance information, using a processor executing a tone waveform forming process, said method comprising the steps of:

receiving performance information;

receiving real-time performance information generated in response to a real-time performance operation;

generating tone waveform samples using said processor, said step of generating including a step of generating a plurality of tone waveform samples in advance of predetermined reproduction timing on the basis of the received performance information and a step of generating a plurality of tone waveform samples in advance of predetermined reproduction timing on the basis of the received real-time performance information, said step of generating being capable of generating the tone waveform samples based on the performance information and the tone waveform samples based on the real-time performance information in a parallel fashion; and

outputting the tone waveform samples generated by said step of generating.

31. A method as recited in claim 30 wherein said step of outputting further includes a step of mixing the tone waveform samples based on the performance information and the tone waveform samples based on the real-time performance information to thereby provide mixtures of the samples, each of the mixtures being composed of the tone waveform samples to be reproduced at a same reproduction timing, and a step of writing the mixtures into an output buffer.

663027-1235460

126

32. A method as recited in claim 30 wherein said step of generating further comprises the step of performing arithmetic operations for generating the tone waveform samples based on the performance information and the tone waveform samples based on the real-time performance information, independently of each other, in such a manner that an advance of the arithmetic operations for the tone waveform samples based on the performance information and an advance of the arithmetic operations for the tone waveform samples based on the real-time performance information differ from each other.

33. A method as recited in claim 32 wherein said step of generating further comprises the step of advancing arithmetic operations for the tone waveform samples based on the performance information within an extent of an available processing capability taking into account a current processing capability of said processor.

34. A method of generating a tone waveform using a processor capable of executing a plurality of different programs on a time divisional basis, said method comprising the steps of:

supplying said processor with application software including at least an image control program for controlling image display, a music control program for controlling tone generation, and a general control program, said music control program including tone color data; and

causing said processor to execute, under control by the general control program, the image control program and the music control program in a parallel fashion, to output image data generated as a result of execution of the image control program and tone waveform data generated as a result of execution of the music control program.

Pub.  
C6

66027-439540

35. A method as recited in claim 34 wherein the supplying step further comprises the step of including in the music control program, within the tone color data, waveform data pertaining to at least one given tone color.

36. A method as recited in claim 34 wherein the supplying step further comprises the step of including within the music control program a tone waveform generating program for generating tone waveform samples on the basis of performance information.

37. A method as recited in claim 34 wherein the supplying step further comprises the step of including, with the application software, software directed to at least one of a karaoke and a game.

38. A method as recited in claim 34 wherein the supplying step further comprises the step of supplying the application software to said processor via a communication network.

39. A method as recited in claim 34 wherein the supplying step further comprises the step of supplying the application software to said processor by setting, in said processor, a transportable medium storing the application software.



40. A method as recited in claim 34 wherein said executing step further includes the steps of:

detecting an available time portion in which said processor is not currently used for any other process than a tone waveform generating process, as an available processing capability for the tone waveform generating process; and

causing said processor to execute the tone waveform generating process based on the music control program, using the available processing capability detected by said step of detecting.

41. A machine-readable medium for use in an apparatus having a processor, said medium including instructions executable by said processor for causing said apparatus to perform a method of generating a tone waveform comprising the steps of:

generating a plurality of tone waveform samples in advance of predetermined reproduction timing;

writing, into a storage, the plurality of tone waveform samples produced by said generating step, said storage being capable of writing and reading, independently of each other, in a parallel fashion;

reading out the stored tone waveform samples from said storage at said reproduction timing; and

controlling writing and reading into and from said storage by said steps of writing and reading independently of each other and also in such a manner that an advance of the writing does not outpace an advance of the reading.

42. The medium as recited in claim 41 wherein said steps of writing and reading into and from said storage further comprise the steps of being performed, independently of each other, in accordance with separate write instruction and readout instruction signals, respectively, and

wherein said step of controlling further comprises the step of controlling the write instruction signal so that the tone waveform samples are sequentially written into said storage from a beginning of a predetermined storage region of said storage and, upon arrival at an end of the predetermined storage region, the writing of the tone waveform samples returns to the beginning of the predetermined storage region and also that a writing location, in the storage region, indicated by the write instruction signal does not get ahead of a reading location, in the storage region, indicated by the read instruction signal.

668027-2235460

43. A machine-readable medium for use in an apparatus having a processor, said medium including instructions executable by said processor for causing said apparatus to perform a method of generating a tone waveform by executing a waveform value calculating process, in parallel with another process, for calculating a tone waveform value for each sampling timing on the basis of performance information, said method comprising the steps of:

detecting a remaining available portion of processing capability of said processor that is not currently used by the other process;

executing the waveform value calculating process based on the performance information using the detected remaining available portion of processing capability so as to generate a given quantity of tone waveform values, wherein said given quantity corresponds to the detected remaining available portion, and storing the generated tone waveform values in a storage section;

determining whether the waveform value calculating process in said step of executing is being executed in advance of given read timing;

when said step of determining determines that the waveform value calculating process is not being executed in advance of the given read timing, calculating a given quantity of tone waveform values on the basis of the performance information and storing the calculated tone waveform values in the storage section; and

generating a tone waveform by reading out, from the storage section, the tone waveform values at the read timing arriving at given time intervals.

44. A machine-readable medium for use in an apparatus having a processor, said medium including instructions executable by said processor for causing said apparatus to perform a method of generating a tone waveform by executing a waveform value calculating process, in parallel with another process, for calculating a tone waveform value for each sampling timing on the basis of received performance information, said method comprising the steps of:

calculating a given quantity of tone waveform values in advance of given read timing, by executing the waveform value calculating process based on the performance information;

storing the tone waveform values calculated by said calculation step in storage locations of a storage section indicated by writing location data and renewing the writing location data;

generating a tone waveform by reading out, from storage locations of the storage section indicated by reading location data, the tone waveform values at the read timing arriving at given time intervals and then renewing the reading location data; and

controlling, in response to a difference between said writing location data and reading location data, calculation progression of said step of calculating.

45. A medium as recited in claim 44 which further comprises a step of detecting a remaining available portion of processing capability of said processor that is not currently used by the other process, and wherein said step of calculating calculates a quantity of tone waveform values corresponding to the remaining available portion detected by said step of detecting, by executing the waveform value calculating process based on the performance information using the detected remaining available portion.

46. A medium as recited in claim 45 wherein said storing step further comprises the step of providing a ring buffer for said storage section.

47. A medium as recited in claim 44 wherein said storing step further comprises the step of providing a ring buffer for said storage section.

668027-1335160

48. A machine-readable medium for use in an apparatus having a processor, said medium including instructions executable by said processor for causing said apparatus to perform a method of generating a tone waveform by executing a waveform value calculating process, in parallel with another process, for calculating a tone waveform value for each sampling timing on the basis of received performance information, said method comprising the steps of:

detecting a remaining available portion of processing capability of said processor that is not currently used by the other process;

calculating a given quantity of tone waveform values in advance of given read timing, by executing the waveform value calculating process based on the performance information;

storing the tone waveform values calculated by said step of calculating in storage locations of a storage section indicated by writing location data and renewing the writing location data;

generating a tone waveform by reading out, from storage locations of the storage section indicated by reading location data, the tone waveform values at read timing arriving at given time intervals and renewing the reading location data;

further calculating a given quantity of tone waveform values, on the basis of a relationship between said reading location data and said writing location data, by executing the waveform value calculating process based on the performance information; and

further storing the tone waveform values calculated by said step of further calculating in storage locations of the storage section corresponding to the writing location data and renewing the writing location data.

49. A medium as recited in claim 48 wherein said storing step further comprises the step of providing a ring buffer for said storage section.

50. A tone waveform generating apparatus comprising:

a processor;

storage coupled to said processor and adapted to store tone waveform values;

a program memory storing instructions executable by said processor for causing said apparatus to generate tone waveforms by executing a waveform value calculating process, in parallel with another process, for calculating a tone waveform value for each sampling timing on the basis of performance information, said program memory comprising the steps of:

detecting a remaining available portion of processing capability of said processor that is not currently used by the other process;

executing the waveform value calculating process based on the performance information using the detected remaining available portion of processing capability so as to generate a given quantity of tone waveform values, wherein said given quantity corresponds to the detected remaining available portion, and storing the generated tone waveform values in said storage;

determining whether the waveform value calculating process in said step of executing is being executed in advance of given read timing;

when said step of determining determines that the waveform value calculating process is not being executed in advance of the given read timing, calculating a given quantity of tone waveform values on the basis of the performance information and storing the calculated tone waveform values in said storage; and

generating a tone waveform by reading out, from said storage, the tone waveform values at the read timing arriving at given time intervals.

51. A tone waveform generating apparatus comprising:

a processor;

storage coupled to said processor and adapted to store a plurality of tone waveform samples; and

a program memory storing instructions executable by said processor for causing said apparatus to generate tone waveforms by executing a waveform value calculating process, in parallel with another process, for calculating a tone waveform value for each sampling timing on the basis of received performance information, said program memory comprising the steps of:

calculating a given quantity of tone waveform values in advance of given read timing, by executing a waveform value calculating process based on performance information;

storing the tone waveform values calculated by said calculation step in storage locations of said storage indicated by writing location data and renewing the writing location data;

generating a tone waveform by reading out, from storage locations of said storage indicated by reading location data, the tone waveform values at the read timing arriving at given time intervals and then renewing the reading location data; and

controlling, in response to a difference between said writing location data and reading location data, calculation progression of said step of calculating.



52. An apparatus as recited in claim 51 wherein said program memory further comprises the step of detecting a remaining available portion of processing capability of said processor that is not currently used by the other process, and wherein said step of calculating calculates a quantity of tone waveform values corresponding to the remaining available portion detected by said step of detecting, by executing the waveform value calculating process based on the performance information using the detected remaining available portion.

53. An apparatus as recited in claim 52 wherein said storage further comprises a ring buffer.

54. A method as recited in claim 51 wherein said storage further comprises a ring buffer.

663027-2283540

55. A tone waveform generating apparatus comprising:

a processor;

storage coupled to said processor and adapted to store data;

a program memory storing instructions executable by said processor for causing said apparatus to generate tone waveforms by executing a waveform value calculating process, in parallel with another process, to calculate a tone waveform value for each sampling timing on the basis of received performance information, said program memory comprising the steps of:

detecting a remaining available portion of processing capability of said processor that is not currently used by the other process;

calculating a given quantity of tone waveform values in advance of given read timing, by executing the waveform value calculating process based on the performance information;

storing the tone waveform values calculated by said step of calculating in storage locations of said storage indicated by writing location data and renewing the writing location data;

generating a tone waveform by reading out, from storage locations of said storage indicated by reading location data, the tone waveform values at read timing arriving at given time intervals and renewing the reading location data;

further calculating a given quantity of tone waveform values, on the basis of a relationship between said reading location data and said writing location data, by executing the waveform value calculating process based on the performance information;  
and

further storing the tone waveform values calculated by said step of further calculating in storage locations of said storage corresponding to the writing location data and renewing the writing location data.

56. An apparatus as recited in claim 55 wherein said storage further comprises a ring buffer.

57. A machine-readable medium for use in an apparatus having a processor, said medium including instructions executable by said processor for causing said apparatus to perform a method of generating a tone waveform based on performance information, said method comprising the steps of:

receiving performance information;

receiving real-time performance information generated in response to a real-time performance operation;

generating tone waveform samples using said processor, said step of generating including a step of generating a plurality of tone waveform samples in advance of predetermined reproduction timing on the basis of the received performance information and a step of generating a plurality of tone waveform samples in advance of predetermined reproduction timing on the basis of the received real-time performance information, said step of generating being capable of generating the tone waveform samples based on the performance information and the tone waveform samples based on the real-time performance information in a parallel fashion; and

outputting the tone waveform samples generated by said step of generating.

58. A medium as recited in claim 57 wherein said step of outputting further includes a step of mixing the tone waveform samples based on the performance information and the tone waveform samples based on the real-time performance information to thereby provide mixtures of the samples, each of the mixtures being composed of the tone waveform samples to be reproduced at a same reproduction timing, and a step of writing the mixtures into an output buffer.

603027-2335460

19

59. A medium as recited in claim 57 wherein said step of generating further comprises the step of performing arithmetic operations for generating the tone waveform samples based on the performance information and the tone waveform samples based on the real-time performance information, independently of each other, in such a manner that an advance of the arithmetic operations for the tone waveform samples based on the performance information and an advance of the arithmetic operations for the tone waveform samples based on the real-time performance information differ from each other.

60. A medium as recited in claim 59 wherein said step of generating further comprises the step of advancing arithmetic operations for the tone waveform samples based on the performance information within an extent of an available processing capability taking into account a current processing capability of said processor.

61. A machine-readable medium for use in an apparatus having a processor, said medium including instructions executable by said processor for causing said apparatus to perform a method of generating a tone waveform by executing a plurality of different programs on a time divisional basis, said method comprising the steps of:

supplying said processor with application software including at least an image control program for controlling image display, a music control program for controlling tone generation, and a general control program, said music control program including tone color data; and

causing said processor to execute, under control by the general control program, the image control program and the music control program in a parallel fashion, to output image data generated as a result of execution of the image control program and tone waveform data generated as a result of execution of the music control program.

65321142205100

62. A medium as recited in claim 61 wherein the supplying step further comprises the step of including in the music control program, within the tone color data, waveform data pertaining to at least one given tone color.

63. A medium as recited in claim 61 wherein the supplying step further comprises the step of including within the music control program a tone waveform generating program for generating tone waveform samples on the basis of performance information.

64. A medium as recited in claim 61 wherein the supplying step further comprises the step of including, with the application software, software directed to a at least one of a karaoke and a game.

65. A medium as recited in claim 61 wherein the supplying step further comprises the step of supplying the application software to said processor via a communication network.

66. A medium as recited in claim 61 wherein the supplying step further comprises the step of supplying the application software to said processor by setting, in said processor, a transportable medium storing the application software.

668027-1395460

67. A medium as recited in claim 61 wherein said executing step further includes the steps of:

detecting an available time portion in which said processor is not currently used for any other process than a tone waveform generating process, as an available processing capability for the tone waveform generating process; and

causing said processor to execute the tone waveform generating process based on the music control program, using the available processing capability detected by said step of detecting.

668027-120910  
68. A tone waveform generating apparatus comprising:  
storage adapted to receive performance information and to receive real-time performance information generated in response to a real-time performance operation; and  
a processor coupled to said storage and adapted to execute a tone waveform forming process, said processor generating tone waveform samples by generating a plurality of tone waveform samples in advance of predetermined reproduction timing on the basis of the performance information and by generating a plurality of tone waveform samples in advance of predetermined reproduction timing on the basis of the real-time performance information, said processor further generating the tone waveform samples based on the performance information and the tone waveform samples based on the real-time performance information in a parallel fashion and outputting the generated tone waveform samples.

69. An apparatus as recited in claim 68 wherein said processor further mixes the tone waveform samples based on the performance information and the tone waveform samples based on the real-time performance information to thereby provide mixtures of the samples, each of the mixtures being composed of the tone waveform samples to be reproduced at a same reproduction timing, said processor further writing the mixtures into an output buffer.

70. An apparatus as recited in claim 68 wherein said processor further performs arithmetic operations to generate the tone waveform samples based on the performance information and the tone waveform samples based on the real-time performance information, independently of each other, in such a manner that an advance of the arithmetic operations for the tone waveform samples based on the performance information and an advance of the arithmetic operations for the tone waveform samples based on the real-time performance information differ from each other.

71. An apparatus as recited in claim 70 wherein said processor further advances arithmetic operations for the tone waveform samples based on the performance information within an extent of an available processing capability taking into account a current processing capability of said processor.

66027-205460

Pub.  
C10

72. A tone waveform generating apparatus comprising:  
storage adapted to store application software including at least an image control  
program for controlling image display, a music control program for controlling tone  
generation, and a general control program, said music control program including tone  
color data; and

a processor coupled to said storage and adapted to generate a tone waveform by  
executing a plurality of different programs on a time divisional basis, said processor  
adapted to execute, under control by the general control program, the image control  
program and the music control program in a parallel fashion, to output image data  
generated as a result of execution of the image control program and tone waveform data  
generated as a result of execution of the music control program.

73. An apparatus as recited in claim 72 wherein the tone color data included in the  
music control program contains waveform data pertaining to at least one given tone color.

74. An apparatus as recited in claim 72 wherein the music control program  
includes a tone waveform generating program for generating tone waveform samples on  
the basis of performance information.

75. An apparatus as recited in claim 72 wherein the application software further  
comprises software directed to at least one of a karaoke and a game.

76. An apparatus as recited in claim 72 wherein said application software is  
supplied via a communication network.

66807-435160

pub.  
P10



77. An apparatus as recited in claim 72 wherein said application software is supplied to said processor by setting, in said processor, a transportable medium storing the application software.

78. An apparatus as recited in claim 72 wherein said processor further detects an available time portion in which said processor is not currently used for any other process than a tone waveform generating process, as an available processing capability for the tone waveform generating process; and said processor further executes the tone waveform generating process based on the music control program, using the available detected processing capability.

663027-2283468